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Veröffentlichungsversion / Published Version
Arbeitspapier / working paper

Zur Verfügung gestellt in Kooperation mit / provided in cooperation with:
Helmholtz-Zentrum für Umweltforschung - UFZ

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UFZ Discussion Papers

Department of Economics

10/2016

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November 2016

Publisher:
Helmholtz-Zentrum für Umweltforschung GmbH – UFZ
Permoserstr. 15
04318 Leipzig

ISSN 1436-140X

Ecological Fiscal Transfers in Europe – evidence-based design options of a transnational scheme

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Abstract:
Ecological Fiscal Transfers (EFT) have recently gained attention as a promising instrument to provide incentives for nature conservation addressing public authorities. In parallel, both the EU and different European countries are exploring new mechanisms to mobilise funding to support biodiversity conservation. So far, existing EFT mechanisms in Europe have been implemented at the national level in Portugal and, to some extent, in France while in Brazil EFT schemes exist between the state and local level. In this paper we develop a proposal for an EFT design within the supranational context of the EU and assess its potential effects with evidence-based estimates. To provide such a knowledge base for a potential supranational EU-EFT implementation, we i) provide a theoretical underpinning, and an analytical synthesis of the current experiences both with the uptake of EFT and the implementation of EU's nature conservation legislation (i.e. the Habitats and Bird Directives), ii) propose a model for an EFT implementation within the existing EU funding framework for N2k financing which is built upon both quantitative and qualitative conservation indicators, iii) compute fiscal effects of our suggested model and analyse how the resulting payments would be (spatially) distributed among European regions, and iv) discuss the model outcomes in terms of ecological effectiveness, distributive effects, and cost-efficiency. Thereby we aim at stimulating a debate about how to better integrate ecological public functions within multi-level and supra-national governance structures.

Keywords: Ecological Fiscal Transfers, European Union, Natura 2000 network, policy advice, spatial econometrics

JEL codes: C31, H77, H87, P48, R12, Q57

Highlights:

- a tailored proposal for upscaling ecological fiscal transfers to EU level
- empirical estimations of socio-economic and bio-geographical characteristics of beneficiaries
- evidence-based policy advice to improve effectiveness of conservation

1 Introduction – the need for innovation in conservation policies

While the Millennium Ecosystem Assessment (2005) and The Economics of Ecosystems and Biodiversity (TEEB) reports (2010) have successfully raised awareness about the importance of healthy ecosystems for human well-being, political measures have not yet been sufficient to halt the decline in biodiversity (Hooper et al., 2012; Waldron et al., 2013). Being at the international forefront in conservation efforts, the EU biodiversity strategy has indeed set ambitious goals for conservation but did not yet produce significant progress (European Commission, 2015, 2011). The European Natura 2000 (N2k) network of protected areas (PA) is a cornerstone of the strategy since transnational habitat and species conservation networks play a crucial role in the protection of important natural heritage (Pereira and Navarro, 2015) and migratory species (Opermanis et al., 2012). However, while N2k provide substantial benefits to both biodiversity and people (ten Brink et al., 2013), the successful implementation yet lacks sufficient financing (Kettunen et al., 2016, 2011; Milieu et al., 2016; N2k Group, 2016).

In this context, there is an increasing interest in the supplementary use of economic instruments to both increase the financing for biodiversity conservation and improve the effectiveness and efficiency of conservation (TEEB, 2010). Nonetheless, conservation policy and its implementation is primarily a public function (Ring, 2002) and thus remains under the public authority. Hence, beyond instruments that address private land users (Vatn, 2015) the conservation policy mix is not complete without instruments that support public bodies in their function to conserve nature (cf. Ring and Barton, 2014).

An innovative instrument that addresses public bodies explicitly is Ecological Fiscal Transfers (EFT). EFT are a portion of intergovernmental fiscal transfers that allocate tax revenue among different government levels according to ecological criteria such as the existence of protected areas (PA). EFT are promising in terms of conservation since i) they do not necessarily require additional funding as such but can be based on introducing changes to existing allocation schemes, and ii) they can be used to incentivise the creation of PAs (Droste et al., 2016, 2015; Grieg-Gran, 2000; May et al., 2002; Ring, 2008a; Santos et al., 2012). Originating from the Brazilian state of Paraná the instrument has spread among other Brazilian states (Droste et al., 2015; Grieg-Gran, 2000; Loureiro, 2002; Loureiro et al., 2008; May et al., 2002; Ring, 2008a; Sauquet et al., 2014). As the first EU Member State, Portugal has introduced a fully fleshed EFT scheme from the national to the local governmental level for all PA categories in 2007 (Santos et al., 2015, 2012)[1]. The idea of EFT has received international attention (May et al., 2002; Ring, 2008a) and it is gaining momentum regarding potential implementations in other states such as Switzerland (Köllner et al., 2002), India (Kumar and Managi, 2009), Indonesia (Irawan et al., 2014; Mumbunan, 2011), Germany (Ring, 2008b; Schröter-Schlaack et al., 2014) and France (Borie et al., 2014). Even an adaptation to the global level has been proposed (Farley et al., 2010).

Given the lack of finance for a successful implementation of the EU biodiversity conservation objectives, including the N2k network, and the potential of EFT to support conservation policies through financial incentives for conservation, the aim of this article is to explore a possible policy design for a potential EU wide implementation of an EFT scheme

[1] Since 2006, a small-scale EFT scheme exists in France which provides ecological transfers for municipalities in core zones of national parks or natural marine parks (Borie et al., 2014).

based on empirical evidence of the distribution of N2k areas and experiences with existing EFT mechanisms. In order to provide the relevant background information, i) we introduce a theoretical foundation for an EU level EFT scheme, and synthesise experiences with ii) EFT, i.e. in Brazil and Portugal, iii) the N2k network creation, i.e. regarding competencies of different government levels, and iii) the current conservation financing within EU funds (section 2). We then present a tailored proposal for a European EFT scheme (section 3). In a next step, we analyse the spatial distribution of simulated EFT payment flows among European regions within the proposed scheme, to display who would benefit from the implementation of an EU-EFT scheme (section 4). Finally, we discuss the potential outcomes of the proposed scheme in terms of conservation effectiveness, distributional effect, and cost-efficiency (section 5) and conclude with a note on the political economy of conservation (section 6).

2 Background – what have we learnt so far?

In order to understand potential design options, we provide a brief theoretical underpinning for fiscal transfers in general and introducing an EU-level EFT scheme in particular (section 2.1). We present the basic functioning of existing national and state-level schemes to local governments in Brazil and Portugal, where EFT were first implemented, that serve as an empirical basis to condense functional elements of EFT schemes for upscaling to the EU level (section 2.2). For a suitable adaptation to the multi-level conservation governance structure of the EU, we elaborate on the implementation of N2k policies (section 2.3) and its existing funding opportunities within the current EU (co-)financing schemes (section 2.4). This way we provide some insights to the institutional framework in which a potential EU-EFT scheme might be implemented.

2.1 A theoretical foundation of an EU-level EFT mechanism

Considering a multi-level government structure, the various levels each have their particular public functions. To fulfil these functions public budgets are required. This is the main reason for revenue sharing and fiscal transfer schemes: to ensure sufficient finances for public functions at all government levels. Furthermore, there are often equity and efficiency considerations that determine the design of the fiscal system (Boadway and Shah, 2009). As a general guideline, the principle of *fiscal equivalence* (Olson, 1969) states that those jurisdictions who obtain the benefits of a policy should also bear the costs of providing it.

There are different forms of fiscal transfers (Boadway and Shah, 2009): *General-purpose transfers* supply sufficient funds for general public functions at the local or regional level. *Specific-purpose transfers* are designed to create incentives for lower-level government to provide specific public goods and services and are thus earmarked for particular spending objectives. The latter may be provided as matching grants that require co-financing from both higher and lower level government sources. A third and hybrid form are output-based or *performance-oriented transfers* which are conditioned on the supply of a particular result but do not necessarily require that received transfers are spent of specified purposes.

In the context of *ecological public functions* (Ring, 2002), these design options have different implications for financing conservation policies. General-purpose transfers increase the general budget and, depending on how the receiving administration allocates the

respective budget, may also increase conservation spending. Specific-purpose transfers are earmarked to support the implementation of a certain policy area or activity and can therefore be used to internalise spill-over benefits between jurisdictions, i.e. where a local policy benefits other local jurisdictions or serves higher level government interests. By lowering the cost of provision for decentral governments they create an incentive for an additional supply from lower government levels. In the case of PA, some benefits remain at local or regional level (e.g. amenity services and local water quality) others spill over to the (inter-)national level (e.g. climate regulation and biodiversity conservation) (Gantioler et al., 2010; ten Brink et al., 2013) – which constitutes a reason for an internalization. Performance-oriented transfers do not necessarily require that the obtained revenue is spent on a particular activity but requires the supply of a specific result and thus maintains some decentral autonomy for how the money is best spent and how the result is obtained. Through performance-based transfers for outputs provision becomes a source of income and thus a greater supply is incentivised. Existing EFT schemes are conditional to ecological indicators such as the (relative) coverage of PA and hence, while based on the logic of general-purpose transfers (i.e. transfers are not earmarked to be used for conservation actions), they are linked to the existence of protected area networks (see section 2.2 for more details). Hence, in the context of fiscal terminology EFT can be considered performance oriented.

In the context of the EU multi-level conservation governance structure there are thus different arguments for different possible types of fiscal transfers or fund mechanism designs. From the perspective of EU level interests, general-purpose transfers may not well serve the purpose implementing conservation policies since they miss a close tie to conservation spending or outputs. Specific-purpose transfers that are dedicated to particular programmes and activities are already in place (see section 2.4 for more detail) and serve two main purposes: they can ensure that spending relates to conservation policies and they could ensure that sufficient funding is available for conservation activities in order to fulfil higher level government interests. Of the two only the first is given, since a N2k funding gap remains and sufficient funding is not ensured (Kettunen et al., 2016, 2011; Milieu et al., 2016; N2k Group, 2016). Performance-oriented transfers, such as EFT, have not yet been implemented in a supra-national governance system.

Summarising the theoretical foundation for a EU-EFT scheme, we argue that

i) positive spill-over benefits from N2k and the realization of EU level interests at decentral levels call for an internalization via fiscal transfers, and
ii) a performance-oriented design would facilitate some decentral spending and implementation autonomy which allows for a greater degree of freedom in realization decentral level interests.

2.2 Current EFT experiences

The very first EFT scheme was developed in the Brazilian state of Paraná in 1991 where a large share of local tax revenue comes from the generation of value-added taxes (Loureiro, 2002). Before 1991 those municipalities that hosted a large portion of state or federal PA were disadvantaged in terms of foregone income through land-use use restrictions imposed by conservation areas and watershed protection. They had thus difficulties to obtain sufficient funds to cover the expenditure of their public functions and required compensation (Grieg-Gran, 2000). An alliance of municipal actors and the state's legislative assembly teamed up

for the creation of a fiscal transfers scheme that included ecological indicators alongside socio-economic indicators (Loureiro, 2002). As a result, municipalities that host PAs now receive a share of tax revenue (in the Brazilian case a portion of the value-added tax). While the original idea of the Brazilian EFT was to compensate municipalities for foregone tax revenue, the scheme evolved and transformed into being perceived as an incentive mechanism for conservation (Loureiro, 2002). The novel instrument also spread among other Brazilian states such that currently 17 out of 26 states introduced EFT in their intergovernmental fiscal transfer law (Droste et al., 2015).

In EFT schemes, as currently in place in Brazil and Portugal[2], municipalities that host PA receive EFT that have no specific spending purposes attached. As these transfers are linked to the existence of PA, we interpret them as output-based or performance-oriented transfers.

Formalising the Brazilian scheme, an environmental index EI_i is calculated (equation 1), that consists of the municipal conservation factor MCF_i, given by the ratio of municipality i's protected areas (PA) and its total municipal area (M) (equation 2), over the state conservation factor SCF, defined by the sum of sum of all n municipalities MCFs (equation 3). Finally, the EI_i is included as a factor in the allocation mechanism of particular tax revenues[3] and its distribution to local governments.

$$EI_i = \frac{MCF_i}{SCF_i} \tag{1}$$

$$MCF_i = \frac{PA_i}{M_i} \tag{2}$$

$$SCF = \sum_{i=1}^{n} MCF_i \tag{3}$$

In the calculation of MCF_i, different PA categories are weighted according to their contribution to conservation goals, ranging from low weights for less land-use restrictive PA and heavier weights for stricter PA (Grieg-Gran, 2000; Loureiro, 2002; Ring, 2008a). Based on this original design further EFT reforms have been introduced in Paraná, which led to the inclusion of additional criteria on the quality of the PA (Loureiro et al., 2008). This takes into account a second quality criterion beyond the PA category weight w, the variation in the quality of the PA or ΔqPA (Loureiro et al., 2008). This criterion changes the calculation of MCF_i by adding a weight according to the change in quality of all m PA into formula for PA of municipality i (equation 4). The respective quality changes are assessed yearly (Loureiro et

[2] While the Brazilian schemes mainly use the share of protected areas on total municipal area in per cent, the Portuguese system uses both the total area under protection in the municipality in hectare and the share of municipal territory occupied by PA. Each municipality receives a certain amount for every hectare of PA within its boundaries, but municipalities with over 70 per cent of PA coverage receive a higher amount per hectare PA (for a detailed description of the Portuguese EFT system, see Santos et al., 2015, 2012). As the Brazilian scheme has the advantage to take account of the relative land-use restrictions imposed by PA irrespective of the jurisdictions' size, we build our EU-level approach on the Brazilian scheme.

[3] In Brazil it is a percentage of about up to 5 per cent of the state-level value-added tax. In Portugal, about 5 to 10 per cent of the General Municipal Fund is allocated according to PA location and coverage.

al., 2008). In Portugal neither the different categories, nor the quality of PA are taken into account (Santos et al., 2012).

$$MCF_i = \sum_{j=1}^{m} \frac{wPA_j}{M_i}(1 + \Delta qPA_j) \quad (4)$$

Regarding the effects of EFT, the first econometric policy evaluation studies have been conducted for panel data of the state of Paraná (Sauquet et al., 2014), all Brazilian states (Droste et al., 2015), and Portugal (Droste et al., 2016). These studies conclude, that after introducing an EFT scheme, municipalities respond to the monetary, fiscal incentive inherent in designating a share of tax revenue to ecological indicators such as PA share by the creation of additional municipal protected areas. However, it is important to note that for such a response to the incentive the existence of respective municipal competencies to designate PA on their own is a requirement (Droste et al., 2016). This is a crucial element for the design of similar schemes: only if the addressed jurisdictions have respective competencies in nature conservation policies, the incentive effect may actually result in enhanced conservation efforts (see section 2.3 for competencies regarding N2k areas).

In summary, the experiences with existing EFT schemes suggest that:

i) they incentivise a positive attitude towards conservation and improve conservation efforts through conditionality on performance for given ecological criteria, while
ii) a respective EU level adaptation would have to take into account the respective conservation competencies of jurisdictions that could receive an EU-EFT scheme, e.g. regarding N2k areas, in order to ignite a response.

2.3 N2k network creation, implementation and decentral competencies

The European N2k network consists of *Special Areas of Conservation* (SAC) defined by the Habitats Directive and the *Special Protection Areas* (SPA) defined by the Birds Directive (Evans, 2012). In total, there are more than 27,000 sites, covering over 18 per cent of EU terrestrial territory and important marine areas (EU, 2015). In terms of target achievement, mid-term evaluation of the EU biodiversity strategy states that the full implementation of the N2k network shows insufficient progress (European Commission, 2015). A recent study regarding the effectiveness and fitness of the Nature Directives found that they are effective "where they are fully and properly implemented [although] … there has been limited progress towards improving the status of most European protected species and habitats [and] … examples suggest that efficiency could be improved by more cost-effective implementation, especially at national and regional level" (Milieu et al., 2016, p. 518). The same study concludes that among the top priority areas for improvement are "the availability of public funding" and the management (plans) of N2k sites (Milieu et al., 2016, p. 520). In order to synthesise experiences with the N2k implementation, i.e. regarding the responsibilities and competencies of different government levels, we will therefore, review the designation process, and the respective competencies of decentral authorities, before discussing financial issues (section 2.4).

Designation process: Basically, the N2k network has been designated by Member States and / or their respective decentral authorities to protect (migratory) species and ecologically important natural habitats and species (Evans, 2012). After an initial proposal of sites from Member States an iterative process via conservation seminars on potentially missing habitats and species in which EU officials, observers and environmental NGOs participated, the N2k area list was continuously determined and specified (Evans, 2012). A relatively recent development is the designation of Marine Protected Areas (or MPA) within the N2k network (Evans, 2012). While it has been stated that N2k started with a technocratic approach it has broadened over time and includes much more (yet not necessarily sufficient) stakeholders by now (Ferranti et al., 2013). This is to say the designation includes expertise from EU conservation officials but also relies upon suggestions and proposal from Member States, their respective decentral levels of government, and from civil society organizations. The official designation of N2k sites is, however, within the legal competence of Member States or their sub-national governments.

The role of local and regional authorities: Article 6 of the Habitat Directive and article 4 of the Birds Directive define that appropriate conservation activities have to be realised and deteriorating activities have to be avoided. While the management plans are optional, 'necessary' conservation measures have to be implemented by the Member States in conformity with the subsidiarity principle (European Commission, 2014). Thus, generally it is the legal obligation of the Member States to provide designated N2k sites and to ensure the favourable conservation status of species and habitats under protection (for a detailed discussion of the legal meaning of favourable see Epstein et al., 2016). The respective planning and management tasks are, however, often delegated to decentral government levels. Of 24 Member States who replied to a questionnaire about EU conservation measures, 14 have explicitly mentioned at least partial decentral *management* responsibilities for N2k sites (European Commission, 2014, Annex II). In about half of the EU states management plans are obligatory for all N2k sites, in some only for particular sites. Conservation measures include statutory, administrative or contractual measures ranging from specifications of legal activities on-site to contracts between authorities and land-owners. Hence, on average, there is some sort of delegating conservation responsibilities to decentral levels and those mainly refer to conservation measures but not so much to plans. Sometimes the implementation is up to NGOs or private land-lords.

Summarising experiences and evaluations of N2k progress, this means that:

i) an improvement of the implementation of the Habitats and Birds Directives in terms of ecological effectiveness and cost-efficiency is needed both at national and regional / local level;

ii) (environmental) ministries and decentral government levels, or the two of them conjointly, are among the key responsible authorities for the implementation of the network and respective improvement mechanisms would have to address them.

2.4 Existing co-financing mechanisms for N2k through EU funds

The establishment and implementation of the Natura 2000 network is mainly financed by the Member States and / or their regional or local authorities although, as per the provision of the EU nature legislation, there is also co-funding available from the EU (Kettunen et al., 2014).

A body of evidence shows that there is a substantial gap regarding the finances available for different conservation activities, including the running cost of N2k managing bodies (Kettunen et al., 2016, 2011; Milieu et al., 2016; N2k Group, 2016). This financing gap is of crucial importance since a fully operational and effective network of PAs requires a range of ongoing management activities such as the restoration of sites. Innovative financing instruments, such as payments for ecosystem services, off-set schemes and fiscal incentives like EFT, have been suggested as means to help to bridge the gap (Kettunen et al., 2016, 2014). Nevertheless, there are a range of funds and financial sources already available within the EU budget to co-finance the establishment and implementation of N2k in Member States (Kettunen et al., 2016, 2014); for an overview see table 1. Both public authorities and private land-users can receive EU funding, but their eligibility varies between different funds.

The main instrument to fund the promotion of the environment within the EU is the Programme for Environment and Climate Action (LIFE) which aims at a shift towards a resource-efficient, low-carbon and climate-resilient economy, environmental protection and nature conservation. About 40 per cent of the LIFE fund is dedicated to the conservation of nature and biodiversity[4] allocated through applications for project calls (Kettunen et al., 2014). LIFE action grants are available for a wide variety of conservation projects ranging from pilot and demonstration to awareness and dissemination projects. But also the European Fund for Regional Development (ERDF) includes of biodiversity protection and restoration, and ecosystem services promotion via N2k as rural development objectives. After all, most EU funds contribute to N2k policies to some extent due to the cross-cutting, integrative nature of EU nature and environment policies (cf. Kettunen et al., 2016; see table 1). Nevertheless, regarding the choice for a suitable EU fund in which a potential EU-EFT mechanism could be implemented most of funds can be dismissed. The EMFF finances fishery and coastal policies and is thus not suited for financing terrestrial N2k. The ESF finances social policies and capacity building but no land use change or N2k management. The CF finances equity and cohesion policies in only particular parts of the EU which does not fit the N2k purpose of protecting important sites and species all over Europe. The EARDF finances conservation activities only in relation to agriculture and forestry policies but N2k are not restricted to those types of land use. H2020 finances research activities which help but do not suffice for N2k implementation. For these reasons, only the LIFE and ERDF funds remain as potential options since both have conservation activities such as N2k implementation as their explicit goals and cover all regions of the EU and thus finance related activities.

One option would be to increase LIFE such that sufficient funding is available at the implementing government levels. From a public finance perspective, such specific purpose transfers (with matching or co-financing conditions) are seen as the most appropriate in order to ensure sufficient funding and internalizing spill over benefits of the realization of higher government level interests. Thus, for closing the N2k financing gap LIFE is the appropriate fund via an augmentation of available co-finances but for performance-oriented funds without spending specifications the ERDF is more suitable. While LIFE targeting is entirely in the hands of the Commission and offers very little if any autonomy, the ERDF finances Rural

[4] Around 75% of the total LIFE funding is allocated to the sub-programme for Environment, of which at least 55% of the resources dedicated to projects financed by way of action grants shall be allocated to support the conservation of nature and biodiversity.

Development Plans (RDP) and operational programmes (OP) defined by Member States or their sub-national jurisdictions. The ERDF requires that portions of the programmes are spent on pre-specified priority areas (depending on economic development stages) but provides quite some regional spending autonomy. Since EFT normally allocate public revenue according to specific ecological criteria such as PA coverage but without earmarking for particular spending purposes the ERDF seems the most appropriate to be enhanced through an EFT like scheme. Generally, the idea of integrating measurable conservation performance indicators into the distributional mechanism of EU-funds like the ERDF is in line with an assessment of the Nature Directives which states that "indicators and targets included in the analysed RDPs and OPs are in general insufficient to allow for proper monitoring and evaluation of results and outcomes in relation to Natura 2000" (Milieu et al., 2016, p. 488). However, for the ERDF there are some preferences for less developed Member States and remote, mountainous or sparsely populated regions. Therefore, this option needs assessing whether resulting EU-EFT payments would be in line with the preferences for marginalised regions.

Summarising, this means:

i) financing opportunities for biodiversity exist also at EU level, but both the current national and EU schemes are not sufficient to respond to the N2k financing needs

ii) according to a public finance perspective the targeted LIFE funding is appropriate to provide sufficient funding for the realization of EU wide conservation interests at decentral levels, and a performance-oriented EU-EFT mechanism could be integrated into ERDF which allows for greater decentral spending authority in order to complement the current funding structure for N2k through setting further incentives while maintaining implementation autonomy.

Table 1: Overview of existing EU funds in relation to N2k co-financing. Source: authors' compilation based on Kettunen et al. (2016, 2014) and respective EU legislation.

abbreviation	full name	major objective	eligible areas	addresses	type of N2k related activities	funding mechanism
LIFE	European financial instrument for the environment	protecting and improving the quality of the environment and halting and reversing bio-diversity loss, including the support of the Natura 2000 network and tackling the degradation of ecosystems	all member states	public authorities, science and private land users	environment and resource efficiency, nature and biodiversity and environmental governance; climate change mitigation, climate change adaptation and climate governance, information	about 40 per cent of LIFE resources are dedicated to project action grants in support of nature and biodiversity conservation
EARDF	European Agricultural Fund for Rural Development	competitive agriculture; sustainable natural resource management; balanced territorial development	preference for less developed Member States	public authorities, science and private land users	restoring, preserving and enhancing ecosystems related to agriculture and forestry	Conditional on rural development programmes that address four of six EARDF priorities with at least 30 per cent expenditure related to the environment (climate, forest, organic farming and N2k)
ERDF	European Fund for Regional Development	investment in SME; sustainable jobs; investment in energy, environment, transport, ICT social, health, research, in- novation, business, and educational infra-structure; networking, cooperation and exchange of experience	preference for less developed Member States and marginalised regions (remote, mountainous or sparsely populated areas)	public authorities, science and private land users	promoting climate change adaptation, risk prevention and management, including supporting investment for adaptation to climate change, including ecosystem-based approaches; preserving and protecting the environment and promoting resource efficiency including protecting and restoring biodiversity and soil and promoting ecosystem services, including through Natura 2000, and green infrastructure	ERDF project implementation in the Member States and regions through operational programmes; support available level depends on the level of economic development in terms of per capita GDP
EMFF	European Maritime and Fisheries Fund	Competitive & sustainable fishery; implementation of	All Member States	Public authorities, science and fishermen	protection and restoration of aquatic biodiversity, enhancement of ecosystems related to aquaculture,	Fund allocation according Member States to fishing

		fisheries policies; balanced territorial development			and promotion of resource-efficient aquaculture	industry size, Member State development of operational programme to be approved by EC with joint implementation
ESF	European Social Fund (ESF);	sustainable and quality employment; labour mobility; social inclusion; poverty reduction; education, training and vocational training; institutional capacity of public authorities	preference for less developed and member states and marginalised regions (remote, mountainous or sparsely populated areas)		enhancement of institutional capacity of public authorities and stakeholders and investment in institutional capacity and in the efficiency of public administrations and public services	ESF project implementation in the Member States and regions through operational programmes; support available level depends on the level of economic development; co-financing rates vary between 50 and 85 per cent depending on per capita GDP
CF	Cohesion Fund	Investment in the environment, sustainable development and energy	Member States with a gross national income (GNI) measured in purchasing power parities less than 90 per cent of the average GNI EU-27	public authorities, science and private land users	promoting climate change adaptation, risk prevention and management, including supporting investment for adaptation to climate change, including ecosystem-based approaches; preserving and protecting the environment and promoting resource efficiency including protecting and re- storing biodiversity and soil and promoting ecosystem services, including through Natura 2000, and green infrastructure	support available depends on the level of economic development in terms of per capita GDP
FP7 & H2020	Framework Programmes for research and innovation	transnational research in a range of priority areas	all Member States and partly associated states	mainly science and SMEs	Research-related conservation activities	Calls for pre-specified research projects

3 Integrating ecological fiscal transfers in EU funds – a design proposal how to allocate performance-oriented transfers to create conservation incentives

The design for a European EFT scheme proposed and tested in the context of this article (see below) is an adaptation of the original scheme in Paraná, Brazil. The Paraná scheme is the most mature EFT mechanism to date, including a continuous improvement of the scheme over time (Loureiro, 2002; Loureiro et al., 2008). Furthermore, in addition to the PA coverage the scheme also takes into consideration variations in PA quality (see section 2.1). The latter is an important element for an adaptation of EFT at the EU level, since the most direct incentive effect in any EFT– comes through a financial compensation for conservation efforts. This constitutes an efficient mechanism of incentivising behaviour that shall exceed the baseline conservation set by EU and national legislation.

Such an incentive, however, only works for jurisdictions that have authority and competency to provide such extra efforts (Droste et al., 2016, 2015; see also section 2.2). On average decentral government levels within the EU such as municipalities or districts do not have particular competencies in designating PA and thereby cannot influence the quantity of N2k sites directly. However, they can often influence the quality of N2k sites due to their responsibilities in PA management (see section 2.3). In order to design an EU-EFT scheme that creates an incentive for conservation efforts and improves conservation outcomes we propose a scheme that is composed by two main parts, one quantitative, and one qualitative measurement. Under such scheme, those jurisdictions that can increase the N2k coverage through additional designations would be incentivised to do so, while those that have PA management competencies only would be incentivised to improve their N2k site management quality efforts (see section 5 for a more detailed discussion of potential effects of an EU-EFT mechanism). Formally, the allocative rule can be expressed as i's jurisdictions' EFT portion of a $fund$ distributed among all $j\ to\ n$ jurisdictions (equation 6)

$$EFT_i = \left(\frac{CF_i}{\sum_j^n CF_j}\right) fund\ , \tag{6}$$

where

$$CF_i = \frac{PA_i}{area_i} + \frac{FCS_i}{habitats_i}\ , \tag{7}$$

the Conservation Factor (CF) is determined by the sum of the share of Protected Area expanse (PA) on total area ($area$) in per cent, and the number of habitats with favourable conservation status (FCS) as a per cent share of the total number of reported habitats ($habitats$) for each jurisdiction i (equation 7). For the subsequent analysis we computed a simulated EU-EFT mechanism according to the above described allocative criteria (see section 4).

Taking into account feasibility of such a mechanism, given the data side of it, there is a constant monitoring of N2k sites (EU, 2015), and Art. 17 of the Habitat Directive and Art. 12 of the Birds Directive require regular quality assessments of the respective N2k habitat statuses and species developments. While the quality monitoring is currently due every six years and has been reported twice, the reporting frequency could be increased once sufficient institutional knowledge has been acquired.

4 Empirical patterns – who would benefit?

In order to assess who (i.e. which areas) would be the beneficiaries of a potential EU-EFT scheme, we analyse the empirical patterns of the spatial distribution of N2k areas among EU-27 NUTS 2 regions. NUTS is the nomenclature of territorial units for statistics (*Nomenclature des unités territoriales statistiques)* and subdivides Member States hierarchically and references the units by a geocode[5]. The system is used in the EU for statistical and analytical purposes but also plays a crucial role in framing EU policies and allocating EU funds, i.e. for ERDF, ESF and CF (Eurostat, 2016). For each Member States there are 3 levels of NUTS – which means the NUTS structure is closely related to the administrative structure of the Member States but they are not necessarily identical. By structuring our analysis according to NUTS 2 regions we do not just have readily available statistical data and can estimate socio-economic characteristics of regions that host PA but we also assess it at a regional level that is closely related to the distributive mechanism of EU funds, such as the one identified as the most suitable one, the ERDF (see section 2.4 for more detail).

4.1 Data sources, preparation and software[6]

The N2k data was retrieved from the European Environment Agency (2015) as shapefiles for the years 2009-2013. From these files the intersection with 2013 NUTS 2 regions (Eurostat, 2015) has been tabulated with a proprietary GIS software such that percentage of N2k area per NUTS 2 region and year was calculated. Data for 2009-2013 on the NUTS 2 regions' area (in km²), GDP per capita (regional gross domestic product in purchasing power standard per inhabitant), population density (persons per km²), tourism (nights spent at tourist accommodation establishments), and unemployment (unemployment rate in per cent) was retrieved from Eurostat (2015). Furthermore, the percentages of the NUTS 2 regions in bio-geographical regions as delineated by the Habitats Directive were computed[7] based on European Environment Agency data (2015). A plotted map of these variables and summary statistics can be found in the appendix. A dataset for the EU-27 NUTS 2 regions was constructed and overseas regions were excluded[8]. Since there were fractions of missing data and this would have led to a large overall loss of information within regressions, missing observations were imputed with the `Amelia` package (Honaker et al., 2011) in the **R** environment (R Development Core Team, 2016)[9] specifying lower and upper limits of (0.001

[5] The code starts with a two letter code referencing the uppermost level of Member States. Each of the following levels is identified by a single numeral (plus a letter in case there are more than 9). NUTS 1 are major economic regions such as regions, states, provinces or groups of them. NUTS 2 are basic regions for the application of regional policies such as counties or planning, territorial or government regions – depending on the Member State. NUTS 3 are small regions for specific diagnoses and may be represented by districts, prefectures or counties. Regarding policy regions "eligible for support from cohesion policy have been defined at NUTS 2 level" (Eurostat, 2016), which therefore provides a suitable data basis for simulating a potential EU-EFT mechanism.

[6] The R code for preparation and analysis, and the prepared data can be found at the a personal github repository: https://github.com/NilsDroste/EFT-EU/

[7] To eliminate inaccuracies in cropping the polygons we re-classified greater or equal 99 per cent shares as 100, and less or equal to 1 per cent as 0. The map of bio-geographical regions can be found in the appendix.

[8] Excluded were EU-27 NUTS 2 regions that are geographically located on other continents: ES70, FRA1, FRA3, FRA3, FRA4, FRA5, PT20, and PT30. Furthermore, Croatia (HR03, HR04) has not been integrated since they became EU member state in 2013.

[9] The fractions of missing values that were imputed are: N2k (0.032), area (0.012), population density (0.011), GDP per capita (0.098), tourism (0.108), unemployment (0.013), and proportion of favourable conservation status (0.005).

and 1.2 times the maximum observed values) and imposing a linear time trend. Missing values were imputed 100 times and these data sets were used to average the imputations. This resulted in a single balanced panel data set with n=266 EU-27 NUTS 2 regions, and T=5 years of observation. The observations for the proportion of habitats in favourable conservation status (European Environment Agency, 2015) were only available for the year 2013 (for the reporting period of 2008-2012). The dataset was thus reduced to a 2013 cross-section subset with n=266 EU-27 NUTS 2 regions[10]. The maps (see section 4.3) have been produced with a combination of the **R** packages `sp` (Pebesma and Bivand, 2005), `maptools` (Bivand and Lewin-Koh, 2015) and `rworldmap` (South, 2011). Additionally, some functions from `spdep` (Bivand and Piras, 2015) have been employed. For the analysis of the spatial distribution of EU-EFT flows on the 2013 subset, a regression tree model was used which was supplied by the `rpart` package (Therneau et al., 2015) and trained through cross-validation with the `caret` package (Kuhn, 2008; Kuhn et al., 2016). Additionally, a random forest model was estimated for robustness checks of the regression tree (Liaw and Wiener, 2002). The summary table has been produced with `stargazer` (Hlavac, 2015).

4.2 Econometric model

In order to analyse where the EFT would flow and in order to account for interactions and non-linearities, we employ a classification and regression tree or so called decision tree model (Hastie and Tibshirani, 2009, chap. 9.2). Tree-based methods partition (multidimensional) data into clusters, groups or regions. The greedy algorithm, also known as recursive binary splitting, proceeds as follows to grow a regression tree (Therneau and Atkinson, 2015). At the first internal node the entire data is split into two regions such that the Residual Sum of Squares is minimised, which means the variable and cut point with the greatest predictive power is chosen. Resulting groups are characterised by statistically significant different averages of the dependent variable; say the left-hand branch has a low average and the right-hand side a high average. The splitting process is repeated for each of the resulting branches until no further gain in explanatory power can be obtained through additional splits. The terminal nodes or leaves of the tree represent the resulting regions or partitions with different average response variable values. For our analysis we use a regression tree with the following structure (equation 8).

$$EFT_i = area_i + popdens_i + GDPcap_i + tour_i + unemp_i + bioregions_i + \varepsilon_i \ , \quad (8)$$

where EFT is monetary flow of EFT payments for region that are allocated among $i, \dots, n$ EU-27 NUTS 2 regions based on the proposed design (see section 3) of an arbitrarily chosen fund size of 1 billion €, $area$ is the area in km², $popdens$ is persons per km², $GDPcap$ is the GDP per capita in PPS (purchasing power standard), $tour$ is the overnight stays in tourist accommodation establishments, $unemp$ is the unemployment in per cent, $bioregions$ is vector of variables measuring the share of area in the respective bio-geographical regions Alpine (ALP), Atlantic (ATL), Black Sea (BLK), Boreal (BOR), Continental (CON), Mediterranean (MED), Pannonian (PAN), and Steppic (STE), and ε is the residual error term.

[10] Covariates data for 2013 is not complete for all NUTS 2 regions. For the missing ones, there is data for previous years – which facilitates an imputation of missing data for 2013 such that we have one complete set of observations for the year for which conservation statuses are reported.

To avoid overfitting, we pruned the tree with a complexity parameter obtained by a tenfold cross validation (Kuhn et al., 2016). Each variable is observed (or imputed, see section 4.1) for $n = 266$ EU-27 NUTS 2 regions for 2013. In order to check for robustness we also employed a Random Forest model that repeatedly grows regression trees and thus allows to average over the ensemble of multiple trees (Liaw and Wiener, 2002). The corresponding variable importance plot can be found in the appendix. At this point it suffices to say that the variables included in the presented regression tree are among the most important ones given a tenfold cross-validated ensemble of 10,000 trees.

4.3 Spatial distribution of N2k sites in EU-27

Figure 1 displays the different components of the proposed EU-EFT design: namely the quantitative part (percentage of N2k coverage in NUTS 2 regions), the qualitative part (proportion of reported habitats that are in favourable conservation status), and the distributional pattern of finances that would be allocated through the proposed mechanism. While the N2k coverage is stronger in Southern and Eastern Europe, there are a couple of regions with a greater proportion of reported habitats that were assessed with a favourable conservation status: northern Sweden, Slovakia, Romania, Southern Germany, Austria, Slovenia, Southern France, Italy, and Southern Portugal. The payments that result from the proposed EFT design are relatively even in their distribution with low payments in the Atlantic region, Poland, and Czechia, and top payments in Cyprus, Romania, Slovenia, Slovakia, and Malta. A histogram of the payments can be found in the appendix.

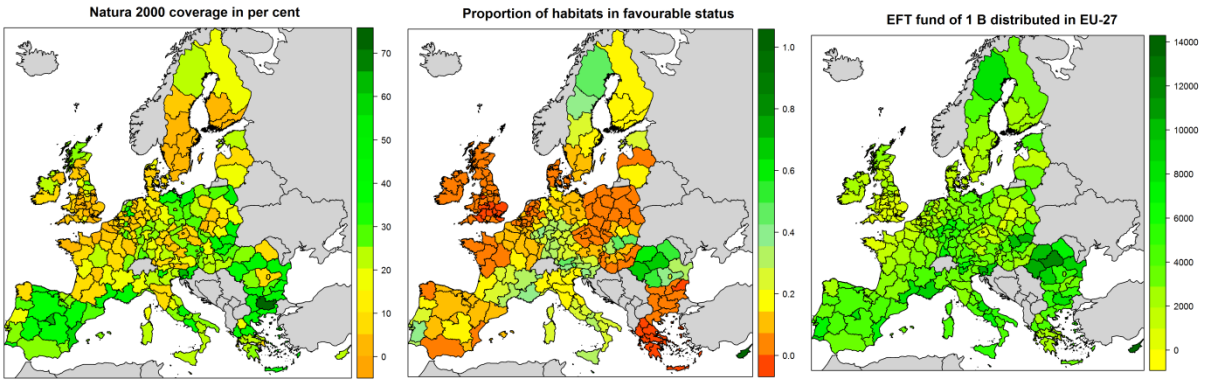

Figure 1: a) Percentage of EU-27 NUTS 2 regions' area covered by N2k sites in 2013; **b)** proportion of habitats in favourable conservation status as by EU-27 Member states reported under Article 17 of the Habitats Directive for the 2008-2012 period; **c)** the distributional pattern of the proposed EU-EFT mechanism for an arbitrary quantity of 1 billion**.** Source: authors' computation based on European Environment Agency (2015).

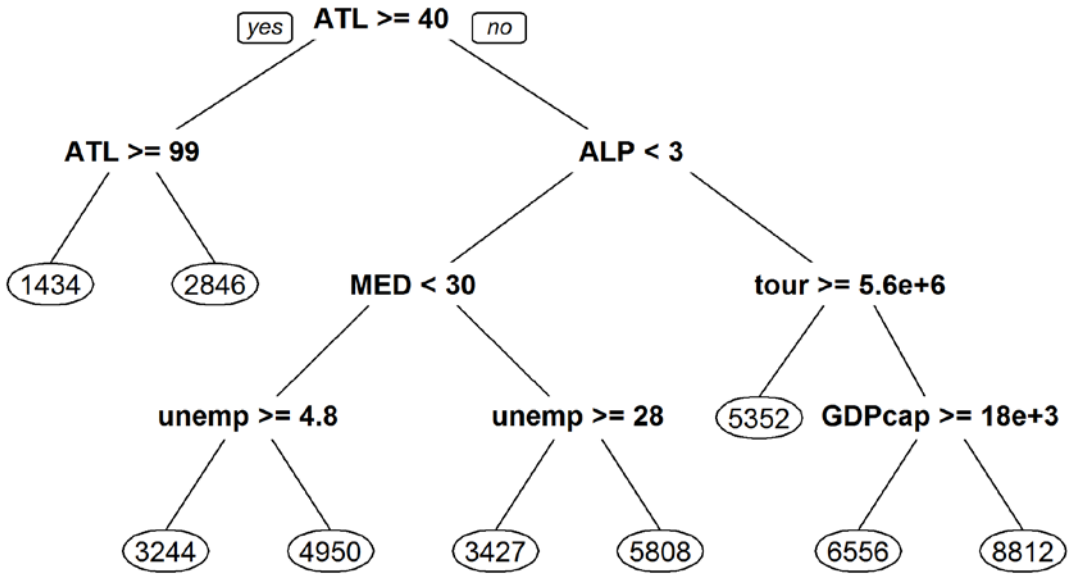

Figure 2: A regression tree for the proposed EU-EFT mechanism, showing to which regions the EFT would flow (final sums are based on an arbitrary 1 billion EFT sum, numbers are given in 1,000 €), each node's decision variable and its partitioning is given in bold, and the variables are: Atlantic (ATL), Alpine (ALP), and Mediterranean (MED) bio-geographical regions, overnight stays in tourist accommodation establishments (tour), unemployment in per cent (unemp), and GDP per capita (GDPcap). Source: authors' computation based on European Environment Agency (2015) and Eurostat (2015).

Figure 2 displays a regression tree, where the EFT payments have been clustered. At each node it splits the data further into subgroups and the final nodes or leaves display the average payment in that particular group. The left branches correspond with a true condition. The tree starts with a split on the Atlantic bio-geographical region, at greater or equal to 40 per cent of the NUTS 2 regions within that region. Together with the second node for the Atlantic regions at greater or equal to 99 this reads: if a NUTS 2 region is ~100 per cent in the Atlantic region, it would on average receive 1,434,000 € out of a 1 billion EU-EFT fund. If it has between 40 and 99 per cent of its area in the Atlantic region, it will receive on average 2,846 €. The third node split at smaller to 3 per cent in the Alpine region and continues with splits for the Meditarranean region, tourist overnight stays, umemployment rates and GDP per capita. For the non-alpine, mediterranean regions, the regions with high unemployment on average receive less EFT payments than the one with lower unemployment. The touristically attractive Alpine regions receive on average high payments but less than the less touristically developed ones. The highest payment receive Alpine regions that have a GDP per capita less than 18,000€. On average this is to say that remote mountainous and economically poor regions would receive the highest EFT payments – which would qualify the proposed EFT mechanism to be in line with the cohesion policy of the ERDF.

5 Discussion – criteria for evaluating outcomes of the proposed scheme

When evaluating the effect of integration of ecological indicators into the allocative rules of EU funds, an environmental policy analysis from a public finance perspective may consider three aspects: ecological effectiveness, the distribution of income, and the efficiency in

resource allocation. We elaborate on each in order to discuss both limits and merits of our proposal.

5.1 Ecological effectiveness

The ecological effectiveness of the EU-EFT could be measured as its contribution to reaching EU biodiversity and conservation goals. In such terms the result of our proposed EFT mechanism would strongly depend on both i) the robustness of the ecological indicators and ii) the governance structures in place. We propose that the EU-EFT scheme is composed of a quantitative indicator measured by N2k coverage of the NUTS2 regions and a qualitative indicator measuring the proportion of habitats reported according to the EU Nature Directives that were assessed with a favourable conservation status. Assuming that the resulting financial flows would actually set an incentive for the regions to enhance N2k sites and / or conservation management such that both or one of these indicators rise, one could expect a significant contribution to the EU conservation goals. Such assertion, however, depends on two factors that limit the certainty of predicting outcomes: the importance of the chosen indicators for reaching the EU conservation goals and the ability of the regions to provide the required actions.

In terms of the first, the N2k sites themselves contribute to reaching multiple goals set in the EU biodiversity strategy. In target 1, action 1, it is mentioned that the N2k network is to be completed and that further species and habitats are to be integrated within and beyond N2k networks (European Commission, 2011). The mid-term review states that the "Natura 2000 network has been largely completed for terrestrial and inland water habitats, covering about 18 % of the land surface"[11] (European Commission, 2015). Thus there seems some but no great political demand for more N2k sites. But the mid-term review also states that the goal of securing and improving a defined percentage of species', birds' and habitats' conservation status shows an insufficient rate of progress and that increased efforts are required. Assuming that N2k sites have to be appropriately established and managed to help to secure good conservation status of threatened species and habitats, the proposed EFT mechanism might help to reach such a conservation goal, especially since our EU-EFT proposal consists in a qualitative part which addresses the proportion of favourable conservation status directly. In this sense, it is crucial to ensure appropriate monitoring of species and habitats so that a reported improvement in conservation status is not just an improvement on paper.

Secondly, a fiscal incentive will only lead to an effect if the targeted jurisdictions have competencies that can correspond to the incentive (see section 2.2). While we have reviewed Member States' responses about management responsibilities (European Commission, 2014, Annex II) and found that a majority of respondents has indicated at least a partial responsibility of decentral public authorities at NUTS 2 level (see section 2.3), this is not necessarily representative. We are furthermore only relatively certain that in most Member States national authorities such as ministries or at least NUTS 1 regions are mainly responsible for the planning and designation of N2k sites. Thus our assumption that through the implementation of an EU-EFT mechanism incentives for both the designation and the

[11] The mid-term review of the EU biodiversity strategy also states that "The marine network coverage has increased to 6 %, still well below the 10 % global target" (European Commission, 2015) which might require an inclusion of marine N2k sites into the proposed EFT mechanism which has so far not be possible due to data limitations.

management quality of N2k sites are set, hinges on the different government and governance structure of the Member States. Since there is an institutional learning and N2k decisions are increasingly organised in a participatory fashion (Ferranti et al., 2013), we would expect that on average decentral authorities have at least some say in the respective planning and/or management procedures. For a more certain response, a comparative study of the exact decision making competencies and planning procedures for N2k sites and management remains a future research question.

5.2 Distributive effects

In the case of the EU-EFT model that we proposed (section 3) the transfers would be allocated according to the share of N2k area on the jurisdictions territory and the proportion of reported habitats in favourable conservation status. According to our assessment of the spatial distribution of resulting EFT payments (section 4), the highest sums would flow to mountainous and economically weak regions – which are very likely disadvantaged ones. The lowest payments would on average flow to the Atlantic region – which is an economically strong region in Europe that neither supplies great proportions of its area as N2k sites nor has it a high ratio of favourable statuses and reported habitats (see Fig.1). If an existing fund, such as the ERDF or LIFE, is allocated differently through an EFT mechanism, there would likely be losers against status quo who are not eligible for reception of that part of the funds any longer. The beneficiaries, mainly remote mountainous and economically less developed NUTS 2 regions (see section 4.3), however, would be well aligned with the cohesion policy goal of the ERDF, which we identified as the most suitable EU fund. If, on the other hand, the EFT fund would be an extra part of an existing fund, but generated from a growth in EU revenue, there might be no losers against status quo but only winners, since everyone would get at least some payments.

But there remains an important element in the distributional effects of our EU-EFT proposal with respect to the chosen ecological indicators. It is a performance-based proposal, which means those that underperform would receive low payments. But those who underperform in conservation efforts might be the ones who need additional conservation funds the most – a problem which cannot be solved by the proposed design but only by specific purpose funds tailored to regions which lack implementation the most. Regarding conservation efforts, early action will be rewarded under the suggested EFT scheme. Those regions who already have made (or had a mandate to make) great conservation efforts in terms of the N2k coverage and / or ecological quality would receive high payments.

Thus, in a nutshell, the proposed EFT mechanism benefits those who perform well in terms of EU nature conservation measures such as the coverage of N2k sites and favourable conservation status of habitats according to the Habitats and Bird Directives – which are mainly rather remote, economically and touristically less developed and mountainous regions. Therefore, the proposed EU-EFT scheme within the ERDF mechanism would be in accordance with EU cohesion policy.

5.3 Cost-efficiency

Considering optimality in terms of cost-efficiency or least-cost provision, it matters which EU-conservation goals are set, e.g. within the EU biodiversity strategy, and at what cost they

can be reached. In this context there is one particularly important differentiation between refinancing fiscal needs for conservation and stimulating performance.

Regarding a closing of an N2k financing gap, it is therefore important to consider, that due to the performance based transfer design without specific spending conditions EFT mechanisms cannot function as an instrument to refinance conservation needs directly. The received revenues can but do not have to be spent on conservation. For closing a general financing gap (Kettunen et al., 2016, 2011; Milieu et al., 2016; N2k Group, 2016) dedicated specific purpose funds are needed that (co-)finance specific conservation tasks that implement the conservation baseline as defined by the EU and national legislation (see section 2.1 and 2.2). For such purpose the better option from a public finance perspective would be to increase specific purpose funds, such as LIFE, which provides project action grants. Our EU-EFT proposal may thus not fully serve to ensure an effective implementation of the N2k Directives.

However, our performance-based approach has the benefit of cost-efficiently incentivising a greater willingness for conservation efforts and introducing a benchmarking or yardstick competition regarding conservation performance in both quantitative and qualitative terms. Our cost-efficiency argument is thus the following: Considering the functioning of EFT from a perspective of rational decision making (which might not resemble the complete picture), especially those jurisdictions likely react to the incentive that have opportunity and / or (EU co-financed) implementation costs lower or equal to the (non-)financial benefits of enhancing their N2k area or quality. Given a policy goal, say target 1 of the EU biodiversity strategy to fully implement the Nature Directives, the goal could be reached at lowest costs. By supplying N2k sites of a high quality, jurisdiction can actually obtain revenue which is unspecified – which makes it an interesting option – i.e. those jurisdiction react first where the N2k can be supplied cheaper (including the existing LIFE or other co-financing measures) than what can be obtain via EU-EFT. In this sense, a EFT-EU scheme can be considered a cost-efficient approach to reach the politically set conservation targets, similar to a standard price approach (Baumol and Oates, 1971). Beyond this benefit of the incentive structure that induces cost-efficient provision our approach induces a benchmarking or yardstick competition: because there is only a limited EU-EFT fund available but N2k sites may increase among several regions, the mechanism introduces a dynamic competitive environment for increasing N2k performance over time.

6 Conclusion – considering the political economy of conservation

In order to support further biodiversity conservation efforts in the EU, we have proposed a design option of a European EFT mechanism to set incentives for nature conservation efforts of EU regions. We have synthesised current experiences with both EFT schemes and N2k financing mechanisms and, building on that knowledge and evidence, developed a possible EFT design for EU level. Such EFT-EU could enhance the current ERDF allocation mechanism through performance-oriented payments based on both quantitative and qualitative N2k indicators without specified conditions on spending the received transfers. To assess potential effects we have simulated the resulting financial flows and analysed the spatial distribution among socio-economic and bio-geographical characteristics of receiving regions.

The main innovative feature of the proposed EU-EFT scheme would be that, while the current EU funding instruments supporting biodiversity conservation, such as LIFE, focus on financing pre-determined objectives and measures, the inclusion of a EU-EFT scheme into the mix of financing instruments would grant performance based transfers without spending conditions to regions that supply most (or best managed) N2k sites. This allows for a greater freedom and autonomy of the receiving public authorities and creates an incentive for a cost-efficient increase in quantity and/ or quality of N2k sites. EU-EFT allocations could be spent how recipients choose, would mainly benefit remote and poor mountainous regions and would thus be in line with the cohesion goal of the ERDF. As such it would represent a valuable complement to current programmes by setting economic incentives for the realisation of EU-wide interest while allowing for the realisation of decentral preferences through payments without spending conditions via establishing performance-based ecological indicators for the funds' distribution. Thereby we provide the first design proposal of an EFT scheme for an adaptation beyond the national context. We have provided evidence to support the analysis and assess potential outcomes of the developed scheme but acknowledge that we only provide predictions.

In this respect, the effective functioning of the proposed mechanisms' incentive depends on actual competencies and decision making power of regional authorities regarding the N2k implementation. Thus, the political economy of conservation in Europe matters substantially for the outcome of implementing an EU-EFT scheme. Considering the political economy of multi-level biodiversity governance, earmarking is politically not always easily acceptable. An EU-EFT scheme building on general-purpose transfers – while not the most effective in terms of bridging the N2k funding gap[12] – has the potential benefit of being more politically acceptable. For example if both quantitative and qualitative N2k indicators are assessed based on regional performance, it thus introduces a yardstick competition from which mainly remote mountainous and economically less developed regions would benefit. This way the EU EFT scheme can be seen as a step towards the right direction and playing the long game by aiming to subtly change attitude towards conservation. Within the EU context future research directions may include a comparative study of the exact decision making competencies and planning procedures for N2k sites and management or an analysis of a corresponding implementation of an EU-EFT mechanism. Beyond the EU context an adaptation to other multilevel contexts such as federalist states or inter- / supranational bodies may pose interesting research questions.

Acknowledgements

ND is grateful for a doctoral scholarship of the Heinrich-Böll Foundation (grant no. P118873). The idea for the current article was inspired by an assessment of existing biodiversity financing mechanism for the European Commission – DG ENV (contract no. 07.0202.2015.712612/ETU/ENV.B.3).

[12] As has been said earlier, the most appropriate measure for closing the N2k financing gap from a public finance perspective is the enlargement of LIFE, which provides co-financing of specific N2k implementation actions.

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Appendix

Table 2: Summary statistics

Descriptive statistics

Statistic	N	Mean	St. Dev.	Min	Max
Ecological fiscal transfer payments (EFT) in 1,000 €	266	3,759.4	2,508.4	2.6	13,364.3
area in square km (area)	266	16,280.1	21,936.1	13.4	226,785.4
population density (pop)	266	480.5	1,251.3	3.4	10,438.2
GDP per capita (GDPcap)	266	25,802.9	10,443.8	8,000.0	86,400.0
tourist overnight stays (tour)	266	9,764,382.0	11,438,209.0	126,378.0	77,692,454.0
unemployment rate (unemp)	266	10.5	6.7	2.5	36.2
Alpine region (ALP)	266	7.0	19.8	0	100
Atlantic region	266	32.5	45.2	0	100
Black Sea region (BLK)	266	0.2	2.0	0	22
Boreal region (BOR)	266	5.3	21.8	0	100
Continental region (CON)	266	33.3	42.9	0	100
Mediterranean region (MED)	266	17.6	36.9	0	100
Pannonian region (PAN)	266	3.5	17.0	0	100
Steppic region (STE)	266	0.4	4.7	0	71

Source: authors' computation based on European Environment Agency (2015) and Eurostat (2015), monetary values are in purchasing power standards (PPS) per inhabitant, except for EFT payments which are based on an arbitrary fund size and rather stand for distributive patterns.

Socio economic control variables:

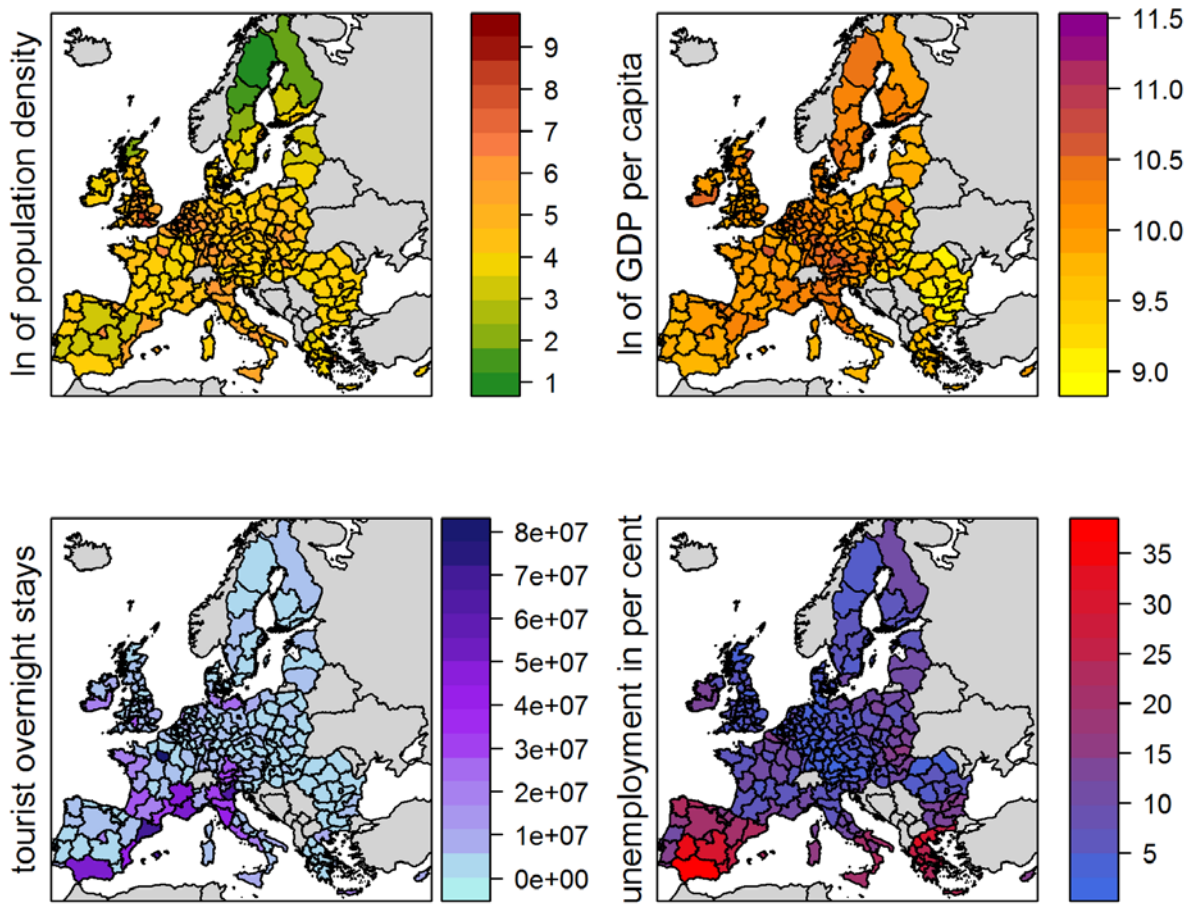

Figure 3: Spatial distribution of covariates for 2013 (log of population density, log of GDP per capita, tourist stays and unemployment rates; from top left to bottom right). Source: authors' computation based on Eurostat (2015).

Bio-geographical regions in Europe:

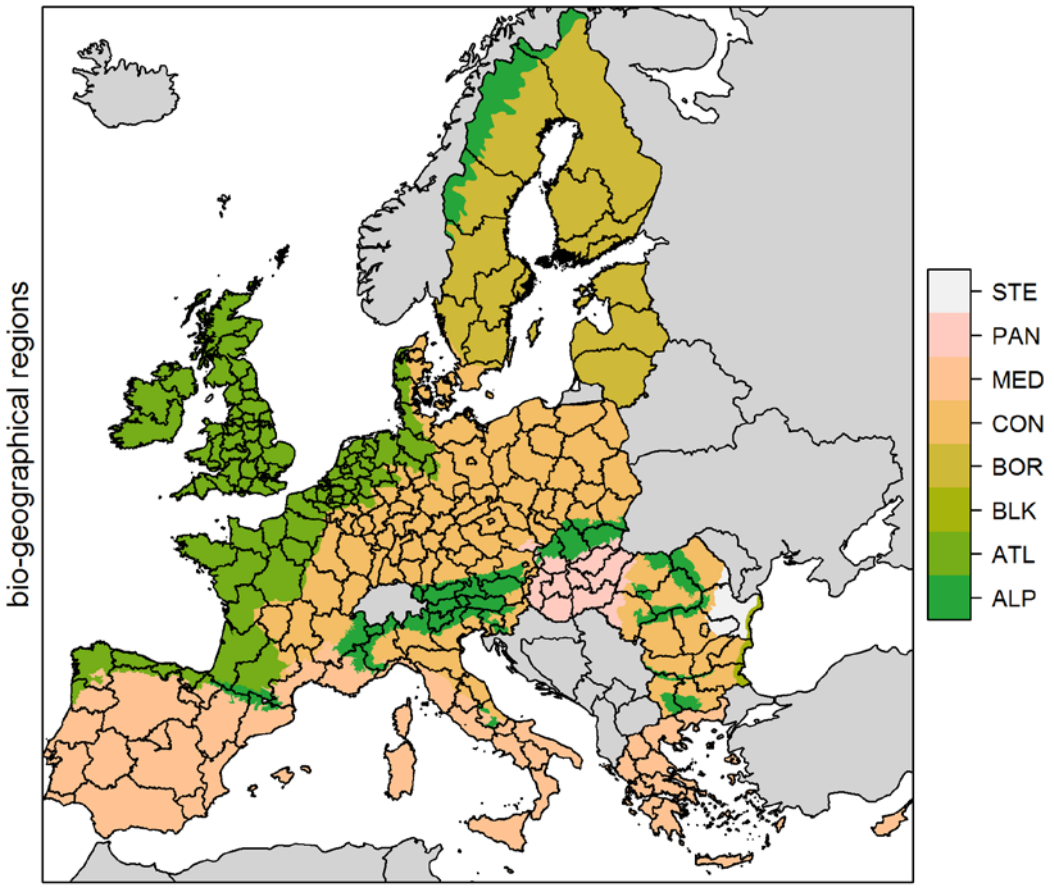

Figure 4: Bio-geographical regions in EU-27 countries (Alpine (ALP), Atlantic (ATL), Black Sea (BLK), Boreal (BOR), Continental (CON), Mediterranean (MED), Pannonian (PAN), and Steppic (STE) regions). Source: authors computation based on European Environment Agency (2015)

Histogram of simulated EFT payments

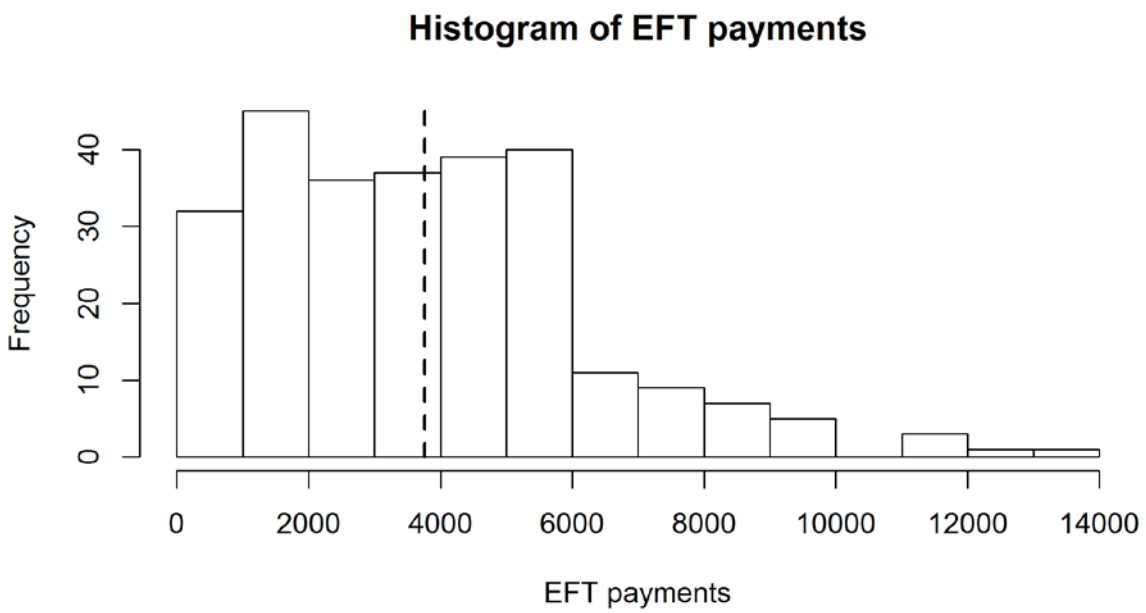

Figure 5: The frequency distribution plot of simulated EFT payments in 1,000 €, with mean at dashed line. Source: authors computation based on European Environment Agency (2015).

Variable Importance Plot from 10,000 regression trees:

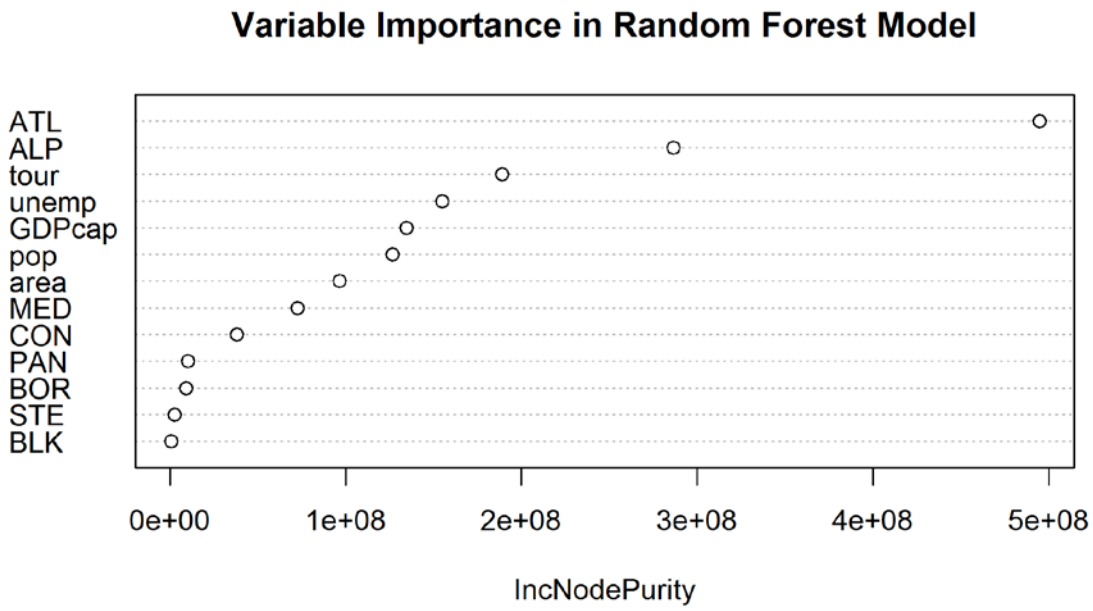

Figure 6: The variable importance of a Random Forest Model with 10,000 trees and a tenfold cross-validation. The x axis display the average increase in node purity by splitting a the variables at the y axis; source: authors computation based on European Environment Agency (2015) and Eurostat (2015). Variables are Atlantic (ATL), Alpine (ALP), Black Sea (BLK), Boreal (BOR), Continental (CON), Mediterranean (MED), Pannonian (PAN), and Steppic (STE) regions). Source: authors computation based on European Environment Agency (2015) and Eurostat (2015).